Does Health Information Matter for Modifying Consumption? A Field Experiment Measuring the Impact of Risk Information on Fish Consumption

Jutta Roosen, Stéphan Marette, Sandrine Blanchemanche, and Philippe Verger

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Center for Agricultural and Rural Development
Iowa State University
Ames, Iowa 50011-1070
www.card.iastate.edu

Jutta Roosen is with the Department of Food Economics and Consumption Studies, University of Kiel, Germany. Stéphan Marette is with the UMR Economie Publique, Institut National de la Recherche Agronomique (INRA), INAPG, and is a visiting scholar at CARD, Iowa State University. Sandrine Blanchemanche and Philippe Verger are with the Met@risk Unit of INRA.

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Questions or comments about the contents of this paper should be directed to Stéphan Marette, e-mail: marette@iastate.edu or marette@inapg.fr.

Abstract

A field experiment was conducted in France to evaluate the impact of health information on fish consumption. A warning given to the treatment group revealed the risks of methylmercury contamination in fish and also gave consumption recommendations. Using difference-in-differences estimation, we show that this warning led to a significant but relatively weak decrease in fish consumption. However, consumption of the most contaminated fish did not decrease despite advice to avoid consumption of these types of fish. Accompanying questionnaires show that consumers imperfectly memorize the fish species quoted in the warning. The results point to the relatively poor efficacy of a complex health message, despite its use by health agencies around the world.

Keywords: econometrics, field experiment, fish consumption, health information, nutrition.

JEL Classification: C9, D8, I1.

1. Introduction

Public health communication programs aim at informing consumers about risks associated with particular products or types of behavior. However, the complexity of messages may entail counterproductive confusion that thwarts the usefulness of the information.

Recently, health agencies from Australia and New Zealand, Canada, Ireland, the United Kingdom, and the United States issued warnings regarding fish consumption. Unlike other consumer warnings, the message about fish involves a complex balance between benefits (with nutritional considerations) and risks (with toxicological considerations). Intense debate about whether or not the benefits of eating fish outweigh the risks has ensued. However, an aspect overlooked in these debates concerns the difficulty in communicating (via doctors, brochures, or the Internet) about numerous fish species that vary in terms of safety or health-promoting characteristics. Knowledge about consumers' tendency to remember different fish species is essential for designing efficient health communication, because it is the specie name that partially conveys information about the competing risks and benefits.

The purpose of this paper is to evaluate the impact of heath information on fish consumption. The risk considered in this paper is posed by methylmercury contamination. A field experiment was conducted in France involving 206 households with at least one child under 15 years of age, since methylmercury risk is particularly important to mitigate in young children. Over three months, we followed the fish consumption of all individuals of these households, who were randomized into treatment and control groups. Only the treatment group received a message based on some existing messages given in other countries and revealing risks of methylmercury with consumption recommendations. This field experiment allows us to measure the impact of information and to compare consumption shifts for both treatment and control groups.

Results show that the health warning led to a relatively weak decrease in fish consumption. The use of the difference-in-differences estimator points out that this decrease is statistically significant. However, the consumption of the most contaminated fish did not decrease despite advice to avoid completely consumption of these types of fish. In addition, numerous consumers from the treatment group did not comply with the recommendation of eating fish at most twice a week. Supplementary questionnaires show that consumers imperfectly memorize the fish species cited in the recommendation. In particular, only tuna that is largely consumed in France was memorized by a significant percentage (50%) of the women who received the information, while other fish rarely consumed were memorized by a minority (10%). The results point to the relatively poor efficacy of this regulatory instrument, a health message of “high” complexity, despite its use in Australia, Canada, Ireland, New Zealand, the United Kingdom, and the United States.

Our approach precisely traces the effect of information on fish consumption by following the same households over three months. This study complements the knowledge about the consumers’ reaction to recommendation about methylmercury by precisely controlling the revelation of information. This paper differs from that of Oken et al. (2003), who did not use econometric estimation or a control for seasonality in their study of the impact of methylmercury information in the U.S. The present paper is the first contribution that follows fish consumption by childbearing women over several months to measure the impact of information about methylmercury. This study paves the way to assessments regarding the recommendations broadcasted by different agencies around the world.[1] Our paper could be useful for refining some

[1] For instance, the U.S. Food and Drug Administration organized a focus group for capturing people’s reactions (FDA, 2005). However, this methodology reveals no information about the impact of information on consumption.

recent studies that used hypothetical situations based on how people might react to dietary advice (see for instance Jakus, McGuinness, and Krupnick, 2002, and Cohen, 2006).

This paper also differs from studies evaluating the impact of information on consumption behavior. Modjuszka and Caswell (2000) and Teisl, Bockstael, and Levy (2001) demonstrated that nutrient labels on food packages affect purchasing behaviors. Moreover, Jin and Lesley (2003) have shown that placards signalling the health inspections of restaurants in Los Angeles have an impact on consumers' choice and the hygiene efforts by restaurants. Conversely, Sloan, Smith, and Taylor (2002) have shown that information campaigns did not have a significant effect on the reduction of consumption of a dangerous product such as cigarettes. Compared to the relative simplicity of nutrient labelling on food packages or restaurant grading in Los Angeles, the health message in our study was relatively long and combined scientific information and consumption advice. The limited ability of consumers to memorize fish species that they have rarely consumed partially explains the limited impact of a medical warning that is not included on the food package. Our approach adds to this economic literature by following both consumption and memorization of the information.

The paper continues with a brief presentation of risks linked to fish consumption. In the following sections, we describe the field experiment and discuss the results. The paper concludes with a discussion of the implications for public health policy.

2. Fish consumption, health risks, and regulatory decisions

Safety and nutrition linked to fish consumption have become an increasing public health concern in recent years (Caswell, 2006). In particular, methylmercury, an organic form of mercury, is a toxic compound that alters fetal brain development when there is significant prenatal exposure (EFSA, 2004). Children of women who consume large amounts of fish before and during pregnancy are particularly vulnerable to the adverse neurological effects of methylmercury (Budtz-Jorgensen et al., 2002). A high level of methylmercury is concentrated in long-lived, predatory fish, such as tuna, shark, and swordfish (Mahaffey, Clickner, and Bodurow, 2004).

The regulatory choice of how to manage this risk is complex since the nutrients in fish are also essential to the health of a developing fetus. More precisely, omega-3 polyunsaturated fatty acids, along with iodine, selenium, and phosphorus, confer benefits to the fetus such as infant cognition and improvement in cardiovascular health. According to the European Food Safety Agency (EFSA, 2005, p. 1), “Fatty fish is an important source of long chain n-3 polyunsaturated fatty acids (LC n-3 PUFA)… There is evidence that fish consumption, especially of fatty fish (one to two servings a week), benefits the cardiovascular system and is suitable for secondary prevention in manifest coronary heart disease. There may also be benefits in fetal development, but an optimal intake has not been established.” In addition, there is still a lot of uncertainty and controversy about whether these benefits may outweigh the harm from mercury exposure.

Several countries have decided to broadcast specific advisories, including the United States, beginning in 2001 (EPA, 2004); Canada in 2002 (Health Canada, 2002); the United Kingdom in 2003 (FSA, 2003); and Ireland (FSAI, 2004), Australia, and New Zealand in 2004 (FSANZ, 2004). The responsible health or food agencies of these countries have given an advisory that vulnerable groups (small children, pregnant women, and women of childbearing age) should consume fish while avoiding species at the high end of the food chain because of high levels of mercury contamination (EFSA, 2004). The broadcast and information programs, which vary among countries, generally use the Internet, mass media, or brochures distributed by gynecologists and obstetricians.

The content and the details of the advisories vary among countries because of idiosyncratic characteristics regarding the patterns of fish consumption and the type of fish commonly caught. Most of the messages stipulate that the most contaminated fish, such as shark and swordfish, should be avoided. However, there are substantial differences regarding the advised limits of consumption for some species. In particular, the limit on tuna consumption is hard to characterize because of the differences of mercury contamination between the fresh (frozen) tuna (namely, the bluefin) and the canned tuna (namely, the albacore, yellowfin, and skipjack).[2] All the messages explicitly mention the benefits of fish consumption while they differ about the details linked to the benefits, since omega-3 or fatty fish rich in omega-3 are not always mentioned.

Since 2001, the United States has been active in disseminating the information for childbearing and pregnant women by using the Internet, mass media, and brochures distributed by gynecologists and obstetricians (EPA, 2004). The 2001 U.S. advisory seemed to have its intended effect, as pregnant women reduced their consumption of fish (Oken et al., 2003). However, the U.S. advisory raised some criticisms by doctors (e.g., Drs. Hibbeln and Golding), who argued in favor of the large benefits of omega-3 fatty acids for fetuses (*The Economist*, 2006b). According to *The Economist* (2006a, p. 14), "The researchers note that American guidelines recommending that pregnant women should not eat fish because it may contain

[2] Note that bluefin tuna (used for steak, sashimi, or sushi) is not mentioned in the U.S. advisory despite an average content in methylmercury similar to those for swordfish and king mackerel (banned by the advisory). According to Knecht (2006, p. 6), "tuna, perhaps the most popular sushi fish, may contain high levels of mercury. 'A lot of people think sushi is a health food, but it isn't if you eat tuna sushi twice a week,' says Eli Saddler, a public health analyst with Gotmercury.org, an environmental advocacy group."

mercury have the perverse effect of cutting off those women (and their fetuses) from one of the best sources of omega-3s.” From a risk management perspective, it is essential to understand how the target audience is receiving consumption advisories.

The French situation is interesting because no major diffusion of information has been decided upon yet. Some warnings, mainly for professionals, have been posted on the Web site of the Agence Française de Sécurité Sanitaire des Aliments, the French food safety agency (AFSSA, 2002 and 2004). However, despite few articles in the popular press (see, for instance, Miserey, 2003, or *Parents*, 2005), no major broadcasting of information, via obstetricians, maternity hospitals, or booklets, was implemented by the health authorities. This absence of national informative campaigns suggests that in France very few childbearing women are informed on the potential risk of methylmercury exposure. In our study, only 12% of the women declared at the end of the study to have known about the mercury problem before the study (see table 7 at the end of this paper).[3]

Because no advisory about risks linked to fish has been communicated to the general public in France, we proceeded by employing a field experiment rather than by observing purchase data in a real market setting. Because of the potential costs to society from inefficient regulation, the following experiment was designed to give evidence on which to base communication by taking into account the consumers’ reaction to information.

[3] One year after the study reported in this paper, the French food safety agency (AFSSA) issued a press release on methylmercury (AFSSA, 2006) that led to a few articles in the popular press (see, for instance, LCI, 2006). Tuna, in particular, is not mentioned in this press release. To the best of our knowledge, no major dissemination of information via obstetricians, maternity hospitals, or booklets is planned in France.

3. The experiment

The previous discussion suggests the choice of some relevant variables for the experiment in order to fit real situations and thus help the public decision maker. We will successively detail the sample, the experiment, the information revealed to the treatment group, and the econometric methodology used for measuring the impact of information.

3.1 The sample

As pregnancy, breastfeeding status, or being a young child are crucial indications for the risks linked to methylmercury, we focus on households with (*i*) at least one women between 25 and 35 years old (childbearing age) and (*ii*) with at least one child under 15 years of age.

We conducted the field experiment in Nantes, a large city in France close to the Atlantic Sea, from May 2005 to September 2005. A sample of 206 households in Nantes and the Loire Atlantique district (West of France) was randomly selected based on the quota method and is representative for age and socio-economic groups for the population of the city. The Loire Atlantique is a coastal district, which means that the consumption frequency of fish in this district is higher than in other French districts far from the sea (see Credoc, 1996).

We recruited by telephone households that consume sea products at least twice a week. During the telephone call, households agreed to have a researcher come to their homes four times and to collect data in a booklet for four months.

3.2 The field experiment

A total of 206 households filled in a monthly notebook with their consumption of fish and shellfish for May 2005, June 2005, and September 2005. This period is a seasonal peak for fresh tuna consumption (see OFIMER, 2005b, p. 81).

The notebook allowed households to record the fish species (with a pre-definite number for the most consumed species), some details about the preparation (filet, salad, pizza, etc.) and the place of the consumption (home or restaurant) for every member of the household. The purchasing receipts were also collected for checking the coherence of the consumption notebook.

Figure 1 describes the experimental design. For the purpose of comparison, information on fish consumption was collected for all members of each household under equal conditions in May. Then, the 206 households were randomized into treatment and control groups, where the treatment group was informed at the end of May 2005 (during the second visit of the interviewer) about the methylmercury risks and the omega-3 benefits linked to fish consumption. The consumption during June 2005 and September 2005 allowed us to measure the effect of information, where the data for June and September consumption was designed to measure the short- and long-term effects of information, respectively.

Only the female household head met the researcher during the four visits and filled in additional questionnaires, since women of childbearing age are the main target of the methylmercury advisories. In addition, mothers largely influence the consumption decisions of their children, the second target group. The four visits are now detailed.

(1) During the first visit (at the end of April 2005), the notebook and the method for collecting information were explained. The interviewer filled in a questionnaire on

nutrition behavior and socio-demographic characteristics of the household. No information was given about the future reading of some nutrition messages. The interviewer explained that a payment would be given on the fourth visit only if the notebook was completed for all three months. An appointment was agreed upon for the second visit.

(2) During the second visit (end of May 2005), the interviewer collected the notebook with the recordings of fish consumption for May. The interviewer checked this notebook. Then, for the treatment group only, the brochure with the message about methymercury (detailed in appendix A and presented in the next section) was read in its entirety to the female household head by the interviewer. The brochure was given to the woman. An e-mail address and a toll-free telephone number for additional information were indicated on the brochure. A notebook for recording consumption for June was handed out. An appointment was made for the third visit.

(3) During the third visit (end of June 2005), the interviewer collected the notebook with the recording of fish consumption for June. The interviewer checked this notebook. Then, for women of the treatment group only, the researcher filled in a questionnaire on the participant's understanding of information received in the brochure and choices made. An appointment was made for a telephone call at the end of August. A notebook for recording the September consumption was given to the woman. At the end of August, during the telephone follow-up, participants were reminded that the notebook had to be filled in for September. An appointment was made for the fourth visit.

(4) During the fourth visit (end of September 2005), the interviewer collected the notebook with the recording of September consumption. The interviewer checked this notebook.

> Then, for the treatment group only, the interviewer filled in an additional questionnaire on the participant's understanding of information received and choices made. All participants also received a €30 payment.

By September 2005, 201 households completed all three monthly notebooks, of which 99 were in the treatment group and 102 were in the control group. Thus, for our study, we kept 99 households in the treatment group with 400 individuals, and 102 households in the control group with 403 individuals. Children under age 6 made up 23.3% of the sample in the treatment group and 24.3% of the sample in the control group.

We now turn to the presentation of the message revealed to the treatment group during the second visit.

3.3 The message revealed to the treatment group

The message was developed based on advisories coming from health agencies in different countries as described in the previous section. While the complete message revealed to women of the treatment group is given in appendix A, it is possible to sum up the types of information delivered at different times as follows. On the first page of the brochure, the group at risk was clearly mentioned. The second page of the brochure insists on the benefits coming from fish consumption, and the existence of omega-3 fatty acids was explicitly mentioned. Information was revealed about the existence of methylmercury.

The third page of the brochure (shown in appendix A) first recalled the group at risk and delivered the consumption advisory.[4] The advisory is structured around three points, as are the U.S. Environmental Protection Agency (EPA, 2004) and Food Safety Authority of Ireland (FSAI, 2004) advisories.

(1) Point 1 of the advisory highlights that the public can "eat up to 2 meals per week" of fish and seafood. We kept the advisory to eat fish up to twice a week, following EPA (2004) and Carrington et al. (2004), which underlined the efficiency of this type of information. This requirement concerns all fish not mentioned in point (2) and (3) and not underlined in grey in table 1 because they have a relatively low level of mercury contamination.

(2) Point 2 of the advisory concerns four fish to "restrict to 1 meal per week." Indeed, as with most advisories, we distinguished between fish to consume up to once a week and fish to avoid (point 3). The criteria for selecting these fish were based on the mercury levels given in the first column of table 1.[5] This leads us to select fish to eat up to once a week that have a mercury content between 0.2mg/g and 0.4 mg/g (underlined in light grey in table 1). The fish to limit to once per week are grenadier, ling (and blue ling), rock salmon, and canned tuna.

(3) Point 3 of the advisory identifies the "do not eat" fish, and it applies to five fish with a mercury content above 0.4 mg/g (underlined in dark grey in table 1). The fish to avoid are grouper, marlin, shark, swordfish, and fresh tuna.

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[4] In order to avoid the duplication of fish in the recommendation, we followed Health Canada (2002) and FSANZ (2004) by not detailing any list of fatty/oily fish (salmon, sardines, or mackerel) or fish low in mercury.

[5] The thresholds of 0.4 mg/g and 0.2mg/g were based on a computation of exposure to ensure that by following our recommendation, children were well within the tolerable level established by the Joint FAO-WHO Expert Committee on Food Additives (JECFA, 2003) and equal to 1.6 µg per kg body weight per week. The fact that children are within the tolerable level implies that childbearing women are within the JEFCA tolerable level.

3.4 Measuring the treatment effect

The main question we seek to answer is if the health message improves consumer behavior. We will present different statistics regarding the weekly consumption frequencies for each individual of the sample (complete results are available from the authors by request).[6]

For measuring the treatment effect, we will apply a difference-in-differences approach that goes back to the work of Card (1992) and Gruber (1994) and that has been applied to measure the impact of health information on food-away-from-home consumption in Jin and Leslie (2003). The equation for analyzing the impact of information is

$$\begin{aligned} Y_i &= \beta_0 + \beta_1 TREAT + \beta_2 JUNE + \beta_3 SEPT + \delta_1 TREAT.JUNE + \delta_2 TREAT.SEPT \\ &\quad + \beta_4 X_i + \beta_5 X_i.TREAT + \varepsilon_i, \end{aligned} \tag{1}$$

where the dependent variable Y_i is the weekly consumption frequency for all months and individuals, *i*, in the treatment and control group. The same regressions are run for the four different categories of fish, namely, all fish, fish not mentioned in the recommendation, fish to limit to once per week, and fish to avoid. Because the same explanatory variables are used in all four equations, independent regressions and the SUR estimation procedure are equivalent.

Explanatory variables of equation (1) are those listed in table 2. TREAT is an indicator variable that equals unity if the individual is in the treatment group and zero otherwise. JUNE and SEPT are dummy variables equal to 1 for the corresponding months and zero otherwise. They allow us to measure seasonal differences in consumption. As the message was given at the end of May to the treatment group, JUNE and SEPT are dummy variables for observations after the information revelation. The vector X_i is a vector of covariates (from MALE to OMEGA3 in

[6] The weekly frequency *Y* for an individual is equal to 7·(*frequency for a given month*)/(*number of days recorded for this month)*, since the number of days recorded was not the same for every household.

table 2) that may explain fish consumption frequencies, and the last term, X_i.TREAT, was included to control for differences in the treatment and control groups.[7] Socioeconomic classes (SEC) are defined according to the job position of the male household head (when no male household head is present, it is replaced by that of the female household head). About a quarter of the sample are workers and in intermediate professional positions. Household incomes are recorded as a categorical variable INCOME ranging from 1 to 8, and DEGREE measures the educational status of the female household head.

The coefficients δ_1 and δ_2 in equation (1) measure the treatment effect. Theses estimators, labelled as the difference-in-differences, estimators can be rewritten as

$$\delta_k = \left(Y_T^k - Y_T^0\right) - \left(Y_C^k - Y_C^0\right) \tag{2}$$

where Y^0 denotes the weekly frequency of interest in May and month Y^k with k=1 for June and k=2 for September. Given that fish consumption may change over time, e.g., for seasonal effects, the effect of information in the treatment group (subscript T) needs to be corrected for the concurrent change in the control group (subscript C), the counterfactual. By assuming different degrees of variation in treatment and control, spurious factors correlated with the variation can be differenced away. What remains is the effect in the treatment group above the effect observed in the control group. These estimators δ_1 and δ_2 can be interpreted as follows. The decline in consumption in the treatment group in June over that of the control group is measured by δ_1 and that for September by δ_2. If both parameters are negative, then the health message has been effective in reducing fish consumption. If δ_2 is smaller in absolute value than δ_1, then the

[7] Given that the data were obtained in a randomized design assigning households into treatment and control group suggests that the difference in consumption frequencies should not be influenced by correlates of group association. Equation (1) allows us to control for observable correlates (cf. Variyam and Cawley, 2006)

message is less effective in the long term than in the short term. We now turn to the results.

4. Results

Before analyzing results for the different categories of fish, we briefly examine consumption patterns, as shown in tables 3 and 4. In particular, table 3 summarizes the weekly consumption data for the three months, namely, May, June, and September. As the message concerns women and children under 6, the results are presented for women, male spouses, kids under 6, and kids over 6. Each of these sub-groups is divided according the treatment/control category. Also recall that only the treatment group received the message at the end of May. An examination of table 3 shows that despite some differences, the consumption patterns are pretty similar among the different members of a family. The main reason is that around 75% of fish consumption occurs at home (with some very tiny differences among the subgroups), so that consumption behavior is highly correlated among members of the same family.[8]

The results concerning the estimates of the weekly consumption frequencies for different categories of fish according to equation (1) are presented in table 4 and allow us to capture the impact of information. Recall that the explanatory variables of table 4 are detailed in table 2. Tables 3 and 4 are now used for presenting results on the information effect for the different categories of fish considered in the message delivered to the treatment group.

[8] This implies that the targeted groups (women and children under 6) mentioned in the recommendation (see appendix 3) cannot be individually targeted in their nutrition choices and do not have a concrete sense as soon as consumption habits are studied.

4.1 Point 1 of the recommendation

The first lines in each block of table 3 detail the weekly consumption frequency for all fish and seafood. This allows us to measure the impact of point 1 of the recommendation ("Eat up to 2 meals per week"). The data show seasonal effects peaking in May and then declining. For the first lines in each block, the decline in consumption between May and June is larger for the treatment group than for the control group, which suggests that information revealed at the end of May matters. On average, weekly consumption of all fish exceeds the recommended level of two servings per week. While this may be due to some seasonality in fish consumption, data of the control group over the three months indicates that this behavior prevails over long periods.

Even if the message implies a significant reduction in fish consumption for the treatment groups, the average consumption frequencies for the treatment group in June and September are still higher than the recommended frequency of two meals in total. Despite some improvement, a vast majority of women did not comply with point 1 of the recommendation, while more kids did comply with it since their consumption is lower than that of their mothers. Before the revelation of the recommendation in May, 20% of women in the treatment group and 52% of young kids in the treatment group were consuming fish twice or less than twice a week. After the revelation of the recommendation in June, 26% of women in the treatment group and 60% of young kids in the treatment group were consuming fish twice or less than twice a week. The revelation of information slightly modifies the number of people complying with point 1 of the message.

The results from the first column in table 4 show that the treatment effect coming from the information revelation on consumption of all fish is effective in June (TREAT.JUNE) and in September (TREAT.SEPT). The coefficients on TREAT.JUNE and TREAT.SEPT are statistically significant, which means there is an information effect (see equation (2)). Because of the health message, the weekly consumption frequency decreases by 1.237 meals per week in June and only by 0.992 per week in September. The coefficient 1.237 partially explains why the revelation of information slightly modifies the number of people complying with point 1 of the message (as previously described), as numerous households had a relatively large frequency of fish consumption. In other words, although the information reduces consumption, this decrease is not sufficient compared to the advisory. Because coefficient -0.992 is smaller in absolute value than coefficient -1.237, this means that the message is less effective in the long term (namely, September) than in the short term (namely, June).

The variable TREAT was interacted with INCOME, DEGREE, MERCURY, and OMEGA3 (see the last variables of table 4).[9] For the other socio-demographic variables, no significant interaction effects with TREAT were detected. Increasing income decreases fish consumption frequency in this sample and a higher level of education is related to more frequent fish consumption. Interacting those two latter variables with the treatment variable shows that those with higher incomes do not reduce by as much their fish consumption whereas those of higher education levels reduce their fish consumption more compared to households with lower education levels. In the treatment group, those more concerned about mercury eat more fish in total (see MERCURY.TREAT). [10] Moreover, fish consumption is slightly lower for those who

[9] The estimation in column 1 of table 4 adds for a variety of controls. In particular, male household heads consume fish less frequently than do female heads. The variables Kids<6 and Kids>6 are not readily interpreted as they are confounded with the age variable that enters via a linear and quadratic term. The age variables show a parabolic curvature of the consumption frequency in age, where for total fish consumption the peak is achieved at about 35 years of age. Given the large number of dummy variables, we define the base situation as the consumption frequency of the female household head in May whose socioeconomic status is an intermediate position (SEC4=1). In comparison to households of SEC4 (intermediate professional position) few of the socioeconomic classes have a significant impact on fish consumption. Being a handcrafter is related to lower fish consumption, though the likelihood of consuming fish whose consumption is recommended to be limited is increased. Households without employment eat fish more often than do other households. SEC7 (retired) was dropped in the estimation as no household was reported to fall into this category.

[10] The mercury question was posed to the treatment group only in June and September; the omega-3 question was posed only in September. For omega-3s we use the same observation in June and September. As no question was

report interest in omega-3 (see OMEGA3.TREAT). This may give hindsight to the fact that households do not sufficiently adjust their fish consumption despite their health concerns.

We briefly turn to fish that are not explicitly mentioned in the recommendation (those not mentioned in points (2) and (3) of the recommendation and not underlined in grey in table 1). Results are presented in the second lines in each block of table 3 and the second column in table 4. They are very similar to the results for all fish. In particular, types of fish that fall under point 1 of the recommendation are consumed too often with an average frequency larger than 2 (see the second lines in each block of table 3). We now turn to the impact of information on the consumption of most contaminated fish.

4.2 Fish mentioned in points 2 and 3 of the recommendation

The third lines in each block of table 3 detail the weekly consumption frequency for fish that fall under the point 2 recommendation ("restrict to 1 meal per week"). On average, households complied with the recommendation that these types of fish be eaten at most once a week.[11] Between May and June, the information leads to a decrease of the consumption of these fish by the treatment group, while the consumption of the control group increases. This decrease in the treatment group is explained by a statistically significant decrease of consumption of canned tuna.[12]

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included in the questionnaires to the control group, the variables related to mercury and omega-3 are given as zero for the control group.

[11] Note that only six women in May were not respecting this point 2 recommendation for eating this fish (including canned tuna) no more than once a week.

[12] Results of two-tailed *t* tests and Wilcoxon tests for paired sample between the frequencies in May and June revealed a statistically significant decrease for canned tuna for the treatment group only, and no significant differences for grenadier, ling, or rock salmon whatever the group.

Columns 3 and 4 of table 4 explain the impact of information on the weekly consumption frequency of fish to limit to once a week. In table 4, a two-step estimation correcting for zero observations is reported in columns 3 and 4 (respectively in column 5 and 6), since 34% of the observations on fish to limit to once a week (respectively 79% of the observations of fish to be avoided) are equal to zero.[13] Columns 3 and 4 of table 4 show that the message reduces significantly the likelihood of consumption with the variable TREAT.JUNE and TREAT.SEPT in the probit estimation (third column of table 4). However, the level of consumption frequencies for those consuming is not significantly affected by the health message (see variable TREAT.JUNE and TREAT.SEPT in the truncated estimation in the fourth column). The information matters for deciding whether or not to consume these fish but not for deciding the consumption frequency.

The last lines in each block of table 3 detail the weekly consumption frequency for fish to be avoided. These fish are consumed very infrequently and the consumption of the treatment group does not change in June or September after the revelation of information. Moreover, the difference-in-differences model for columns 5 and 6 of table 4 does not detect an effect of the health message. Consumers do not react in terms of consumption to the recommendation advising them to avoid entirely these most contaminated fish. A plausible explanation for the lack of impact from the message comes from the episodic consumption of these fish, which does not help consumers to memorize the names of these fish.

[13] The two-step estimation consists of a probit model estimating the positive consumption frequencies and an OLS estimation of the relation between covariates augmented by the inverse Mills ratio (IMR) and the dependent variable for the positive observations. The parameter to the IMR is described as Sigma. The two-step estimation goes back to Cragg (1971) and is more general than a simplifying Tobit approach that restricts the effect of each covariate on the likelihood of a positive consumption and on the extent of the consumption to be the same.

From questionnaires, table 5 provides some indications of women's perceptions in the treatment group. Table 5 shows that, except for tuna, only a minority of women were able to recall the species mentioned in the recommendation, signalling some limits to memorizing points 2 and 3 of the recommendation. The correlation between the percentage of recall at the end of June (first column of table 5) and the habit of consumption in May 2005 for the women of this study (fifth column of table 1 for the underlined fish in dark and light grey) is very high (0.82). Clearly, fish with a low level of recollection (<20%) are rarely consumed. Tuna, widely consumed in France, is recalled by around 50% of the treatment group women, with a noticeable difference between fresh and canned tuna. This significant memorization may partially explain the significant decrease of canned tuna consumption by the treatment group between May and June. There are no major changes regarding the recollections between June and September. Such results raise the issue of the relevance of mentioning species that consumers fail to remember. Note that very few consumers spontaneously recalled fish not mentioned in the recommendation, which suggests the absence of major mistakes in terms of remembered species containing a high level of mercury.[14]

Table 5 also shows that the advised frequencies mentioned in the recommendation were only correctly indicated by a minority of women (15% or less), when species were successively mentioned to these women in questions following the question about the spontaneous recall. This result means that the "complexity" introduced by the need to differentiate between points 2 and 3 in the recommendation results in very little differences in terms of memorization by women. The previous results suggest that the efficacy of the message is relatively limited.

[14] In June, only four women of the treatment group spontaneously identified herring, fatty fish, or salmon as fish containing a high level of mercury. Only one woman spontaneously recalled salmon as a fish whose consumption should be limited. In September, only one woman spontaneously identified salmon as a fish whose consumption should be limited.

4.3 Understanding of the message

Table 6 shows that the message was clear, credible, and understandable (see the first four lines). Women judge mercury content of fish as an important health matter, in particular for child health (lines 6 to 8). This judgment is somewhat less acute in September compared to June, which confirms the lower impact of the information in September compared to June (see also TREAT.JUNE and TREAT.SEPT in the three first columns of table 4). However, on average, the women put a higher value on the benefits of omega-3 fatty acids coming from fish consumption (9 to 10). These valuation of benefits linked to fish consumption could explain the relatively weak decrease of fish consumption after the revelation of the recommendation (an explanation that is not captured by the last lines of table 4).

The most interesting result is that only 25% of women receiving the information explicitly mentioned a modification of their fish consumption. Moreover, the fact that only 12% searched for additional information suggests a weak concern regarding this risk. Clearly, this raises the issue of diffusing health advisories when three-quarters of the treatment group are not ready to change consumption behavior.[15] Figure 2 details the reasons given by the group of 75% who did not declare a modification of their consumption. The main reasons given were the fact that species mentioned in the recommendation are not consumed and that households do not feel concerned about the risk. As we selected consumers who frequently consumed fish (consuming sea products at least twice a week), it is likely that consumers with lower frequencies of fish consumption do not feel concerned about methylmercury risk.

5. Policy implications and conclusions

The results of this study have implications for health policy in France and in the other OECD countries using the messages. Although it is beyond the scope of our study to perform a cost-benefit analysis of regulatory options by taking into account consumer and producer surplus, decisionmakers should carefully consider the following points.

The advantage of using a medical warning or recommendation for pregnant women and women of childbearing age is the transparency of the message and a transfer of responsibility from the risk manager to the consumer. The inconvenience for the policy maker is a weak impact on consumption and public health. In terms of the empirical results, this paper showed that revelation of information led to a significant but insufficient change in fish consumption. Given the limited impact, the regulatory choice of informing groups at risk should come at a relatively low cost in order to be acceptable. One possibility for informing at low cost would be to choose a media outlet that already exists for communicating health information to pregnant women. For instance, a booklet entitled *Bien manger en attendant bébé* [Eating well during pregnancy] edited by CERIN (Centre de Recherche et d'Information Nutritionnelles) is largely distributed in France through the offices of gynecologists, obstetricians, and at maternity hospitals. This booklet only mentions the consumption of fatty fish (salmon, sardines, etc.) twice a week as beneficial for the development of the fetus. It would be possible to add information about methylmercury and fish consumption and a more detailed advisory for choice of fish species.

However, selecting the fish to mention in the recommendation is a tricky task. The present paper challenges the efficacy of recommendations (existing in some OECD countries), by

[15] Because (in September) 43% of women did not keep the message sheet, perhaps a recommendation written on a sticker for posting on the refrigerator would be kept by more women and would be more efficient in terms of memorization.

showing that the episodic consumption of the most contaminated fish (fresh tuna, shark, swordfish, marlin, and grouper) was not modified and that, except for tuna that is widely consumed, a vast majority of consumers did not recall the species (see table 5). An alternative message in a recommendation could be to mention only the first point of our recommendation (see appendix A), namely, “Eat up to 2 meals per week of fish and sea products.” Another possibility would consist of mentioning the previous point with tuna only, since half of the women memorized tuna (see table 5). Nevertheless, these solutions seem aimed only at thwarting the poor efficacy of a recommendation rather than actually improving the nutritional outcome.

Even if this study concerns French consumers, it raises the question of the efficacy of the recommendation for women of childbearing age largely used by the United States (EPA, 2004), Canada (Health Canada, 2002), the United Kingdom in 2003 (FSA, 2003), Ireland (FSAI, 2004), Australia and New Zealand (FSANZ, 2004). First, despite idiosyncratic differences, consumption patterns are very close among western countries (see Jensen, 2006). Second, the species to avoid in these existing recommendations are scarcely consumed in the respective countries, similar to the case in France. The absence of memorization of fish to avoid (as in table 5 with the absence of spontaneous recall and the poor result regarding the frequency) is likely to be similar for these countries, with the notable exception of tuna.

As Burros (2006, p. 1) notes for the United States, “If fish sales are any guide, many people appear to understand that fish is good for them but that tuna should be eaten sparingly. Sales of canned tuna from October 2004 to October 2005 dropped 9.8%, according to Information Resources Inc., a market research firm. But fish consumption has increased 12% since 2001, up from 14.8 pounds per person a year to 16.6 pounds per person in 2004.” Consequently, the results of the third lines of each block of table 3 that mainly came from a decrease of canned tuna consumption are "close" to what emerged (with some national specificity) in the United States after the recommendation broadcasted by the EPA-FDA in 2004 (EPA, 2004).[16] Eventually, according to RealMercuryFacts (2006), the U.S. recommendation resulted in some difficulties for U.S. consumers to quote species with a high content of mercury, which is "close" to our findings in table 5.

Our paper shows that medical recommendations/warnings to pregnant women or women of childbearing age (via brochures or Internet) are not a panacea and that alternative tools might be considered. Mandatory labels or placards posted on the products in the supermarkets or in restaurants (see Knecht, 2006) can be an alternative or a complement to recommendations.[17] For instance, a label on the package with the statement "young children and pregnant women should not eat this fish because of a high concentration of methylmercury" could be posted on the most contaminated fish (fresh tuna, shark, swordfish, marlin, and grouper) quoted in point 3 of the recommendation (see appendix A) and/or the fish of the point 2 recommendation (canned tuna, rock salmon, grenadier, and ling). Such a label given directly on the fish package would circumvent the difficulties surrounding the memorization of the different species from the recommendation. The targeting of only the most at-risk populations (young children and pregnant women or women of childbearing age) on the label should calm the fears of David Acheson, a food safety director for the U.S. FDA, who noted that "if you start labeling everything with mercury levels, there will be a concern that mercury is a bigger deal than it actually is, and all segments of population will say 'I just don't want to take the risk'" (Adamy, 2005, p. D4). The labeling issue is complex since the toxic exposure depends not only on the

[16] If figures of our study are not comparable with the 9.8% slump of canned tuna in the U.S. between October 2004 and October 2005, the consumption frequency of canned tuna for the treatment group dropped 21% on average from May to June in our study, while the consumption frequency of canned tuna for the control group was almost stable.
[17] Monitoring the restaurants' placards could be very costly for the regulator.

contamination of the product but also on the amount of fish consumed. A proposal for mandatory labeling on canned tuna regarding mercury was recently dismissed by a Court in California after intense lobbying by the canned tuna industry (Waldman, 2006).[18] The battle over labeling in the United States is not over, since supermarkets recently decided to post the FDA warning on their fish shelves (Progressive Grocer, 2006).

Eventually, the minimum-quality standard eliminating the “most contaminated” fish for each type of species could be tightened in Europe. This standard could concern the fish (fresh tuna, shark, swordfish, marlin and grouper) quoted in point 2 of the recommendation (see appendix A) and/or the fish of point 3 of the recommendation (canned tuna, rock salmon, grenadier, and ling). One possibility would consist of amending the existing European Regulation No. 78/2005 (European Commission, 2005) to lower the level of mercury allowed for predatory fish sold on the European market. While the maximum level of mercury is 0.5 mg/kg for fish, the maximum level of mercury is 1 mg/kg for predatory fish listed on page 3 of the Commission Regulation (EC) No 78/2005 (see fish with * in table 1). This could lead to a decrease of the standard for all predatory fish to 0.5 mg/kg as for the other fish. Because of the lack of precise data, it is difficult to predict the amount of predatory fish with a mercury level above 0.5 mg/kg that would then be withdrawn from the market. The fish withdrawal and the cost of testing, as in the large-scale testing system developed by *Micro Analytical System* (Adamy, 2005), would be costly for fisheries. Based on our results underscoring a limited effect of the information, the minimum-quality standard may be more convincing for limiting the exposure of both childbearing-age women and children, even if economically it is not viable for fisheries and furthermore may lead to a welfare loss of groups not at risk.

[18] Imposing a mercury label on tuna cans may also entail risks of label proliferation, as dolphin-safe labeling is already posted on numerous cans in the U.S. and Europe (see Teisl, Roe, and Hicks, 2002).

Beyond the previous considerations about the policy, this paper has shed light on the relatively poor efficacy of recommendations, which occurs mainly because consumers imperfectly memorize the mentioned fish species. We hope that this paper has contributed further facts for the debate and will help regulatory authorities and parliaments refine their policies regarding the risks from fish consumption.

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Table 1. Description of fish codified to consumers: Mercury contamination, purchases, and consumption in France

Fish	Mean Mercury (mg/kg raw fish)	Mean Methyl mercury (mg/kg)	Purchases: Market Share 2003 Volume [c]	Purchases: % Women and Children Purchasing 2002 [d]	The Present Study: % of Women Consuming May 2005	The Present Study: % of Children Consuming May 2005
Anchovy	0.065	0.055	n.a.	15%	7.8%	6%
Anglerfish or monkfish*	0.153	0.128	2%	4%	12%	10%
Cod	0.121	0.102	7%	48%	38.3%	52%
Dab	0.050	0.042	1%	8%	2%	2%
Grenadier*,[b]	0.212	0.176	1%	n.a.	7.3%	8%
Grouper*,[a]	0.465	0.390	n.a.	n.a.	0.5%	1%
Hake	0.083	0.069	3%	19%	22%	22%
Hake (Alaska)	0.082	0.069	9%	79%	58.3%	84%
Halibut*	0.162	0.136	n.a.	0%	1.5%	1%
Herring	0.040	0.033	n.a.	27%	5.3%	3%
Ling or blue ling*,[b]	0.271	0.226	1%	18%	15.5%	14%
Mackerel	0.074	0.062	7%	55%	26%	23%
Marlin*,[a]	0.485	0.411	n.a.	n.a.	0.5%	0.2%
Perch	0.096	0.081	3%	14%	8%	8%
Pike*	0.099	0.083	n.a.	n.a.	3%	2%
Red mullet	0.136	0.114	1%	4%	2.4%	1%
Rock salmon or dogfish*	0.289	0.243	1%	7%	3%	5%
Salmon	0.034	0.029	10%	56%	64.6%	64%
Sardine	0.062	0.052	7%	52%	24%	26%
Sea bass*	0.094	0.079	1%	3%	9.7%	5%
Sea bream	0.095	0.077	1%	3%	7.8%	5%
Shark*,[a]	0.988	0.831	n.a.	n.a.	0.5%	0%
Skate*	0.156	0.131	1%	8%	9.7%	7%
Sole	0.100	0.084	2%	11%	23%	24%
Swordfish*,[a]	0.976	0.814	n.a.	n.a.	1.5%	1%
Trout	0.050	0.041	3%	23%	10%	7%
Tuna, canned*	0.329	0.277	27%	96%	76%	53%
Tuna, fresh*	0.813	0.683	2%	7%	40%	34%
Whiting	0.093	0.078	3%	30%	17%	18%
Other fish (unspecified)	0.162	0.136	8%	n.a.	39%	31%

Sources for Mercury: Crépet et al. (2005, table 1, pp. 181-182) for methylmercury.

[a] FDA (2001) for the mercury content (with the methylmercury equal to the mercury content times 0.84).

[b] IFREMER, 1994-1998. Résultat du réseau national d'observation de la qualité du milieu marin pour les mollusques (RNO) and MAAPAR, 1998-2003. Résultats des plans de surveillance pour les produits de la mer. Ministère de l'Agriculture, de l'Alimentation, de la Pêche et des Affaires Rurales.

Sources for purchases and consumption:

[c] OFIMER (2005a). Percentage based on the sum of sold volume of fresh, frozen, and canned fish purchased by consumers (tables p. 21, 23, and 26).

[d] SECODIP (2002).

*Predatory fish listed as defined by CAC (1991) and completed by list from the Commission Regulation (EC) of March 8, 2001, No 466/2001, and by the Commission Regulation No. 78/2005 (European Commission, 2005). The five fish to avoid in the recommendation of the appendix A (point 3) are underlined in dark grey. The four fish to consume once a week in the recommendation (point 2) are underlined in light grey.

Table 2. Descriptive statistics of sample based on individuals

	Variable Description	Treatment		Control	
		Mean	**Std. dev.**	**Mean**	**Std. dev.**
TREAT	Dummy variable =1 if in treatment group and zero if not.	1		0	
JUNE	Dummy variable =1 if observation in June and =0 if not.	0.333		0.333	
SEPT	Dummy variable =1 if observation in September and =0 if not.	0.333		0.333	
MALE	Dummy variable =1 if male household head, =0 if not	0.233		0.243	
KIDS < 6	Dummy variable =1 if child under age of six, =0 if not	0.318		0.328	
KIDS > 6	Dummy variable =1 if child over age of six, =0 if not	0.203		0.176	
AGE	Age in years	19.468	14.693	19.494	14.665
SEC1	SEC = Dummy var. indicating socio-economic class defined by profession of	0.020		0.000	
SEC 2	male household head (female if no male	0.050		0.094	
SEC 3	household head exists)	0.218		0.107	
SEC 4	(SEC1= Farmer; SEC2=Handcraft	0.240		0.392	
SEC 5	SEC3=Cadre superieur ;	0.180		0.117	
SEC 6	SEC4 =Intermediate Profession;	0.258		0.270	
SEC 7	SEC5=Employee; SEC6=Worker	0.000		0.000	
SEC 8	SEC7=Retired; SEC8=Student	0.000		0.007	
SEC 9	SEC9=No profession)	0.035		0.012	
INCOME	Categorical variable indicating household revenue 1 = <600 €, 2 = 600-900 €, 3 = 900-1200 €, 4 = 1200 – 1500 €, 5 = 1500-2300 €, 6 = 2300-3000 €, 7 = 3000 – 6000 €, 8 = more than 8000 €	5.494	1.167	5.395	1.403
DEGREE	Categorical variable indicating last degree of female household head 1= no/primary degree, 2= secondary degree, 3= baccalaureat, 4= bac + 2 years, 5 = bac+ more than 2 years	3.553	1.278	3.722	1.176
MERCURY[a]	How dangerous do you consider the mercury risk in fish? 1 = no risk … 5 = very strong risk	2.349	1.883	0.000	0.000
OMEGA3[b]		3.932	0.878	0.000	0.000
No. of households		99		102	
No. of individuals		400		403	
No. of observations		1200		1209	

[a] The question was posed to the female household head of the treatment group in June and September regarding the risk of mercury for herself, her husband, and her children.
[b] Same as MERCURY but this question was only asked in September. The response was used to explain consumption in the treatment group for June and September.

Table 3. Reported weekly consumption frequencies of women, men, and children by fish type (on average)

	Treatment			Control		
	May	**June**	**Sept.**	**May**	**June**	**Sept.**
Female household head						
All Fish	3.23	2.82	2.83	2.93	2.82	2.65
Fish not mentioned	2.61	2.29	2.39	2.33	2.21	2.15
To limit to once a week	0.51	0.43	0.34	0.53	0.53	0.40
Fish to avoid	0.10	0.10	0.10	0.08	0.09	0.09
Male household head						
All Fish	2.70	2.25	2.37	2.69	2.59	2.30
Fish not mentioned	2.24	1.83	2.05	2.17	2.02	1.85
To limit to once a week	0.38	0.32	0.24	0.44	0.50	0.34
Fish to avoid	0.08	0.10	0.08	0.08	0.07	0.11
Children under age 6						
All Fish	2.17	1.90	2.07	2.08	2.04	2.13
Fish not mentioned	1.85	1.64	1.76	1.76	1.68	1.79
To limit to once a week	0.27	0.22	0.26	0.28	0.31	0.27
Fish to avoid	0.04	0.04	0.05	0.05	0.05	0.07
Children over age 6						
All Fish	2.82	2.30	2.42	2.09	2.23	2.16
Fish not mentioned	2.33	1.91	2.04	1.67	1.80	1.79
To limit to once a week	0.42	0.33	0.29	0.38	0.40	0.32
Fish to avoid	0.07	0.07	0.09	0.03	0.03	0.05

Table 4. Estimates of the weekly consumption frequencies

Fish categories	All fish	Not mentioned	To limit to once a week		Fish to avoid	
	OLS	OLS	Probit	Truncated	Probit	Truncated
CONSTANT	-0.293	-0.150	-1.137**	-0.446	-2.472***	0.523
	(0.452)	(0.390)	(0.494)	(0.376)	(0.553)	(0.328)
TREAT	0.547***	0.583***	-0.112	-0.031	0.118	0.096
	(0.199)	(0.172)	(0.213)	(0.166)	(0.239)	(0.149)
JUNE	-0.047	-0.069	-0.089	0.131**	-0.146	0.069
	(0.087)	(0.075)	(0.097)	(0.065)	(0.109)	(0.061)
SEPT	-0.138	-0.093	-0.440***	0.078	0.239**	-0.037
	(0.087)	(0.075)	(0.095)	(0.069)	(0.103)	(0.057)
TREAT.JUNE	-1.237***	-0.916***	-0.854**	-0.441	0.654	-0.069
	(0.336)	(0.290)	(0.358)	(0.288)	(0.404)	(0.249)
TREAT.SEPT	-0.992***	-0.715**	-0.781**	-0.361	0.281	0.153
	(0.327)	(0.282)	(0.348)	(0.274)	(0.393)	(0.244)
MALE	-0.453***	-0.367***	-0.178**	-0.140**	-0.094	0.024
	(0.079)	(0.068)	(0.087)	(0.057)	(0.089)	(0.045)
KIDS<6	1.482***	1.150***	1.150***	0.442	0.383	-0.286
	(0.345)	(0.298)	(0.378)	(0.281)	(0.417)	(0.237)
KIDS>6	1.120***	0.900***	0.879***	0.293	0.326	-0.285*
	(0.250)	(0.216)	(0.276)	(0.200)	(0.298)	(0.166)
AGE	0.137***	0.095***	0.129***	0.047**	0.048*	-0.008
	(0.022)	(0.019)	(0.024)	(0.019)	(0.027)	(0.016)
AGE^2	-0.002***	-0.001***	-0.002***	-0.001	-0.001	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
SEC1	0.246	0.173	1.085***	-0.063	-0.169	-0.191
	(0.260)	(0.225)	(0.402)	(0.193)	(0.319)	(0.238)
SEC2	-0.409***	-0.367***	0.333***	-0.308***	0.238**	-0.077
	(0.107)	(0.092)	(0.122)	(0.089)	(0.120)	(0.062)
SEC3	-0.139*	-0.036	-0.219**	-0.084	-0.147	-0.142**
	(0.081)	(0.070)	(0.087)	(0.067)	(0.097)	(0.060)
SEC5	0.090	0.104	-0.080	-0.002	0.094	-0.060
	(0.088)	(0.076)	(0.094)	(0.070)	(0.103)	(0.058)
SEC6	0.027	0.054	0.070	-0.032	-0.063	-0.148***
	(0.075)	(0.065)	(0.082)	(0.058)	(0.092)	(0.054)
SEC8	0.624	0.907**	-1.028**	0.430		
	(0.417)	(0.361)	(0.456)	(0.377)	-	-
SEC9	1.496***	1.052***	0.155	0.849***	0.041	-0.096
	(0.181)	(0.156)	(0.201)	(0.117)	(0.210)	(0.126)
INCOME	-0.053**	-0.041*	-0.017	-0.012	-0.023	0.004
	(0.026)	(0.023)	(0.029)	(0.021)	(0.031)	(0.017)
DEGREE	0.194***	0.166***	0.013	0.006	0.235***	0.015
	(0.032)	(0.027)	(0.035)	(0.024)	(0.039)	(0.023)
INCOME.TREAT	0.193***	0.101**	0.119**	0.139***	0.125**	0.039
	(0.052)	(0.045)	(0.056)	(0.044)	(0.063)	(0.042)
DEGREE.TREAT	-0.150***	-0.075*	0.097*	-0.145***	-0.342***	-0.070*
	(0.051)	(0.044)	(0.055)	(0.042)	(0.060)	(0.036)
MERCURY.TREAT	0.098**	0.105***	-0.029	-0.039	0.016	-0.006
	(0.045)	(0.039)	(0.048)	(0.038)	(0.053)	(0.028)
OMEGA3.TREAT	-0.079*	-0.095**	-0.005	0.033	0.013	-0.016
	(0.045)	(0.039)	(0.048)	(0.038)	(0.053)	(0.032)
Sigma				0.539***		0.276***
	-	-	-	(0.021)	-	(0.016)
No of Obs.	2256	2256	2256	1480	2256	469
R-Square[a]	0.146	0.119	0.072		0.056	
No. of correct predictions			1511		1791	

[a] In the case of the probit model in table 4 we report Efron's R-Square.
Standard errors in parentheses. *,**,*** marks significance at the 10%, 5%,1% level, respectively.

Table 5. Recollection regarding fish species and the frequency of recollection of species mentioned in the message by the women in the treatment group

	End of June		End of September	
Species mentioned in the message	Species recalled by the % of women	Frequency correctly recalled by the % of women[a]	Species recalled by the % of women	Frequency correctly recalled by the % of women[a]
Grouper	6%	11%	13%	9%
Marlin	5%	10%	3%	6%
Shark	20%	15%	28%	14%
Swordfish	10%	14%	19%	13%
Tuna, fresh	52%	13%	50%	10%
Grenadier	4%	10%	4%	10%
Ling	6%	10%	4%	14%
Rock Salmon	4%	13%	10%	13%
Tuna, canned	44%	26%	43%	27%

The five fish to avoid in the recommendation of the appendix A (point 3) are underlined in dark grey.
The four fish to consume once a week in the recommendation (point 2) are underlined in light grey.
[a] In the case of frequencies, each fish was quoted to the women, who were asked to give a frequency among various possibilities including the reply “I do not know”. These questions were asked after the question about the message and the recall (spontaneous quotation) of species.

Table 6. Descriptive statistics linked to the perception of the message by female household heads of the treatment group

Variables	Definition	June	September
Clarity of the message	1 = not at all … 5 = completely	4.50 (0.75)	
Message understandable	1 = not at all … 5 = completely	4.16 (0.56)	
Credibility of the message	1 = not at all … 5 = completely	3.85 (1.02)	
Complete message	1 = not at all … 5 = completely	3.58 (1.16)	
Alarmist message	1 = not at all … 5 = completely	3.19 (1.24)	
Risk of mercury for health (for you)	How dangerous do you consider the mercury risk in fish? 1 = no risk … 5 = very strong risk	3.52 (1.00)	3.19 (1.11)
Risk of mercury for health (for your kids)	How dangerous do you consider the mercury risk in fish? 1 = no risk … 5 = very strong risk	3.93 (1.03)	3.51 (1.12)
Risk of mercury for health (for your spouse)	How dangerous do you consider the mercury risk in fish? 1 = no risk … 5 = very strong risk	3.47 (1.24)	3.20 (1.21)
Benefit of omega-3 (for you)	How are the benefits of the omega-3 fatty acid in fish? 1 = no benefit … 5 = very strong benefits		3.93 (0.86)
Benefit of omega-3 for your kids)	How are the benefits of the omega-3 fatty acid in fish? 1 = no benefit … 5 = very strong benefits		3.96 (0.88)
Benefit of omega-3 for your spouse)	How are the benefits of the omega-3 fatty acid in fish? 1 = no benefit … 5 = very strong benefits		3.93 (1.27)
Declaration regarding the modification of fish consumption	Did you modify your consumption of fish after the recommendation? % of yes among the women in the treatment group		25%
Women knowing about mercury before the study	Did you know the mercury risks before the study? % of yes among the women		12%
Brochure kept at the end of September	Did you keep the message sheet given at the end of May? % of yes among the women		57%
Complementary information	Did you search for complementary information after the message revelation? % of yes among the women		12%

Average and standard deviation in parentheses for the 11 first lines.
% of all respondents of the treatment group for the 4 last lines.

Figure 1. The timing of the experiment

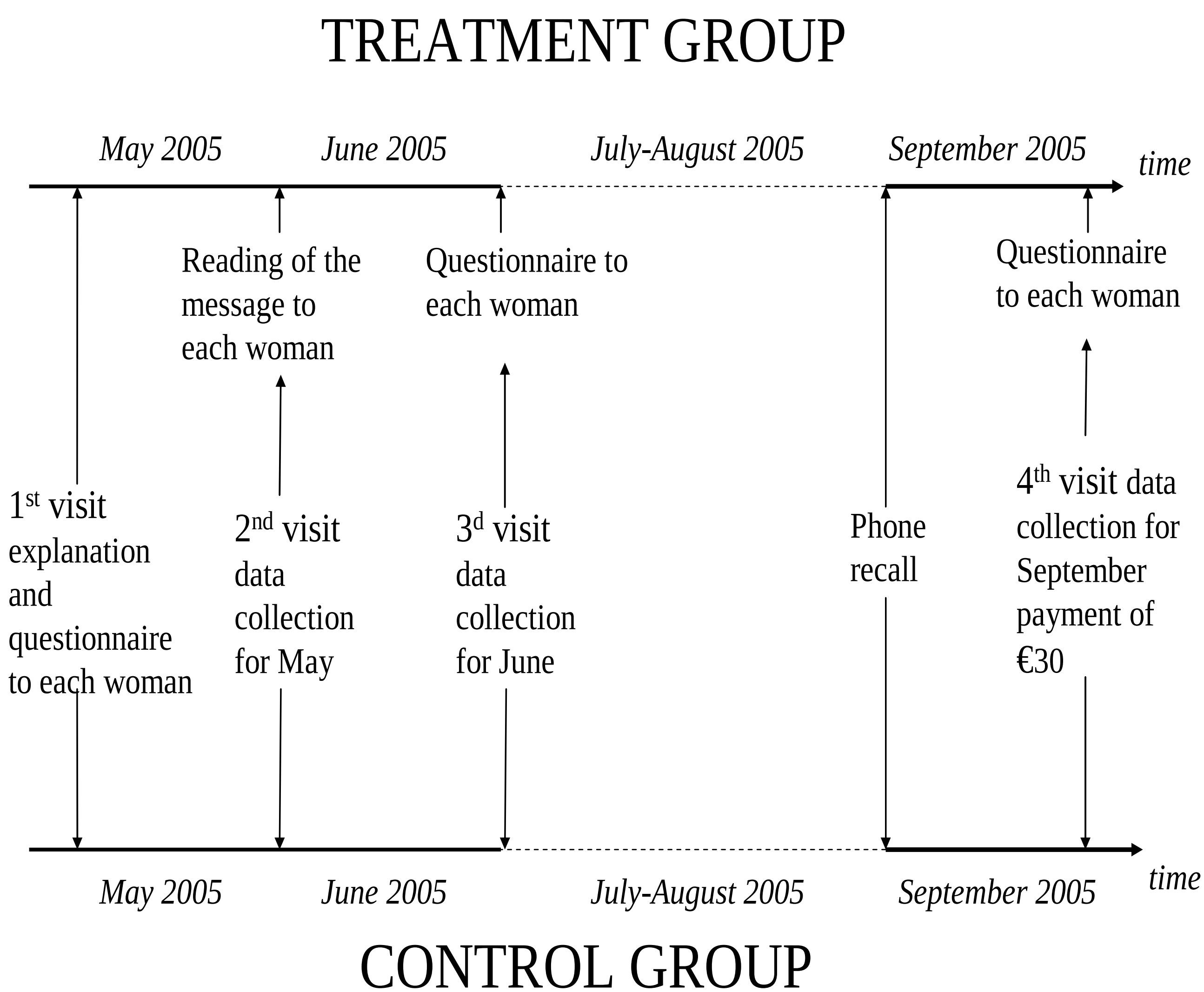
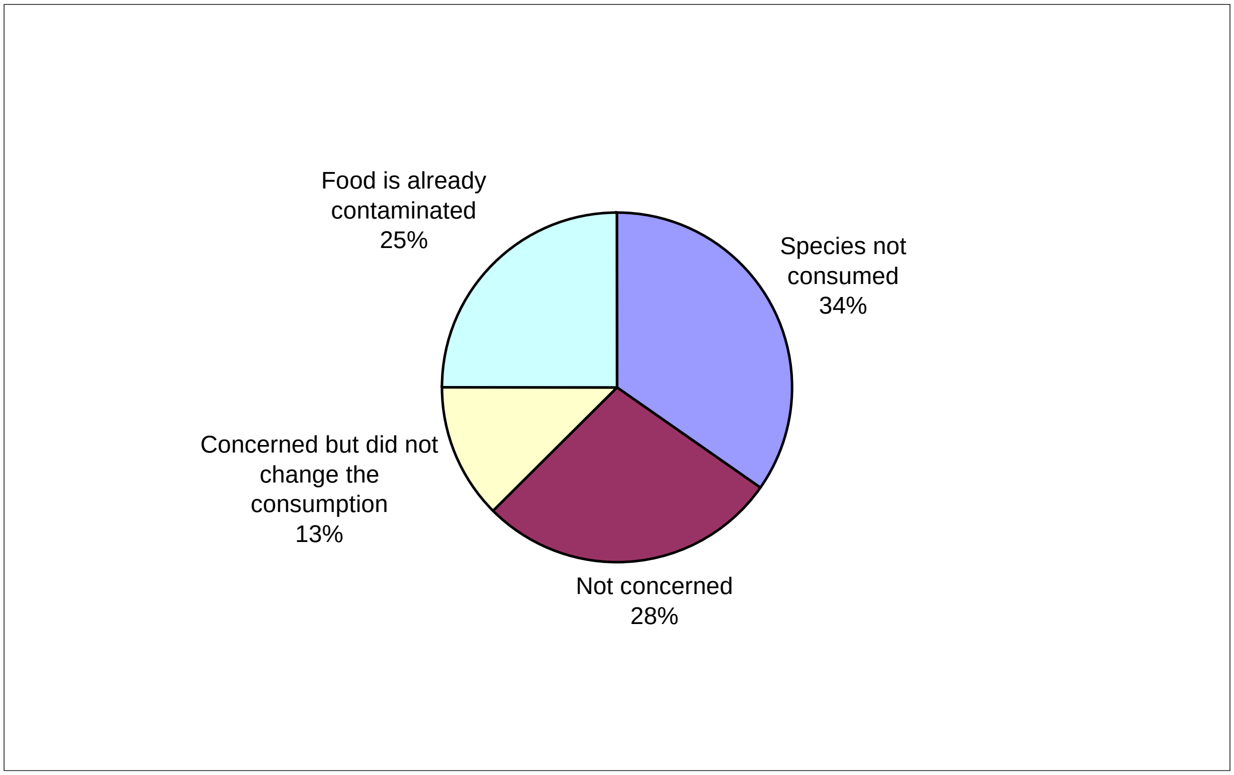


Figure 2. Reasons given for explaining the absence of modification in fish consumption by 75% of women of the treatment group



APPENDIX A

The Message (Translation)

What You Need to Know About Mercury in Fish and Sea Products

Recommendations for

Women Who Might Become Pregnant
Pregnant Women
Nursing Mothers
Young Children

Page 1 of the brochure.

Mercury and health concerns

Several medical studies have led the European Commission and public health authorities from numerous countries (including France, the United States, and New Zealand) to set up recommendations regarding fish consumption.

Fish is important for a balanced diet. Fish is a good source of proteins, vitamins, and minerals. Fish content is high in omega-3 fatty acids and low in saturated fat.

Regular consumption of fish helps to reduce the risks of cardiovascular diseases and it contributes to brain development and growth of children.

However, fish contains methylmercury (an organic form of mercury) naturally present in water and coming from industrial pollution. All fish contain traces of methylmercury. Through accumulation, larger fish that have lived longer have the highest level of methylmercury.

Effects of mercury on health have been shown in several medical studies. The results of these studies show a lack of brain development in the fetus and in children exposed to mercury.

Consumers always benefit from the nutritional effects of fish. However, pregnant women and young children have to restrict their consumption of most contaminated species.

Page 2 of the brochure.

Recommendation for

Women Who Might Become Pregnant
Pregnant Women
Nursing Mothers
Young Children (under 6)

1. **Eat up to 2 meals[19] per week** of fish and sea products.
2. So, when choosing the 2 meals, **restrict to 1 meal per week** the consumption of:
   - canned tuna
   - or rock salmon (dogfish)
   - or grenadier
   - or ling (blue ling)
3. **Do not eat** :
   - fresh tuna
   - shark
   - swordfish
   - marlin
   - grouper

These recommendations are based on both French consumption habits and methylmercury contamination of fish and sea products sold in France.

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For additional information, contact

Email
Phone number

Page 4 of the brochure.

[19] An average portion per meal is equal to 150 g for an adult and 100 g for a young child.
For canned tuna, an average portion is equal to 60 g for an adult (a small can) and to 30 g for a young child.

APPENDIX B

Predictions of Consumption Frequencies

The results of the difference-in-differences estimation in table 4 are used to predict the consumption frequencies for all four fish categories and all four types of household members. The following table reports the predicted changes in weekly consumption frequencies.

Table B.1. Change in consumption: Predictions from the difference-in-differences estimation

	Treatment					Control				
				Change May=100					Change May=100	
	May	June	Sept.	June	Sept	May	June	Sept.	June	Sept
Female household head										
All fish	3.19	2.76	2.88	-13.4%	-9.7%	2.92	2.87	2.78	-1.60%	-4.7%
Not mentioned	2.57	2.23	2.37	-13.0%	-7.6%	2.33	2.26	2.24	-2.98%	-4.0%
Limit to once a week	0.42	0.32	0.24	-25.0%	-42.1%	0.41	0.42	0.28	1.83%	-31.2%
Fish to avoid	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Male household head										
All fish	2.79	2.38	2.50	-14.7%	-10.1%	2.53	2.48	2.39	-1.85%	-5.4%
Not mentioned	2.27	1.94	2.09	-14.5%	-8.0%	2.03	1.97	1.94	-3.41%	-4.6%
Limit to once a week	0.31	0.25	0.15	-20.4%	-51.3%	0.31	0.32	0.19	2.48%	-38.4%
Fish to avoid	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Kids under age of 6										
All fish	2.30	1.92	2.04	-16.5%	-11.1%	2.08	2.03	1.94	-2.3%	-6.6%
Not mentioned	1.94	1.65	1.79	-14.9%	-7.4%	1.73	1.66	1.63	-4.0%	-5.4%
Limit to once a week	0.16	0.13	0.07	-20.8%	-55.8%	0.18	0.19	0.08	5.7%	-53.6%
Fish to avoid	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Kids over age of 6										
All fish	2.68	2.34	2.43	-12.7%	-9.4%	2.27	2.23	2.14	-2.1%	-6.1%
Not mentioned	2.20	1.93	2.03	-12.2%	-7.4%	1.85	1.78	1.76	-3.8%	-5.0%
Limit to once a week	0.31	0.23	0.16	-25.8%	-49.2%	0.31	0.31	0.21	-0.2%	-32.4%
Fish to avoid	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Comparing these predictions with those in table 3 shows that the model yields satisfactory results for all consumption categories except for the category “fish to avoid.” Given the large amount of zero observations in this last category of fish, the probit model performs relatively poorly in predicting positive outcomes and hence final predictions result almost always in zero consumption levels.

The results of this last table show that total fish consumption decreased by about 15% for total fish consumption and fish to be consumed twice a week in May for all household members in the treatment group. This decline is much stronger in the treatment group compared to the control group where the seasonal decline is only about 3%. In addition, we also observe a strong decline in the treatment group in the fish to be consumed only once a week in spite of consumption increasing in the control group. Differences in change in consumption between May and September are much less pronounced between the treatment and control group. As expected, we observe a declining efficacy of the message over time.